CLAIMS

What is claimed is:

1. A projection apparatus comprising:

an illumination system to emit white light having light of a predetermined wavelength band;

a polarization conversion system, to convert the light of the predetermined wavelength band to a first polarization component;

a color recycling system to separate the light of the predetermined wavelength band into a first color light and a second color light, transmit and reflect the first and second color lights, to convert a third color light to have a second polarization component, and transmit the third color light so that a fourth color light, that is a mixture of the first and third color lights, and a fifth color light, that is a mixture of the second and third color lights, progress in different optical paths;

an image forming system comprising a first reflective panel and a second reflective panel, which respectively modulate the first and second color lights according to an applied image signal, and a third reflective panel, which modulates the third color light according to the applied image signal;

a screen to receive the first through third color lights modulated by the image forming system and projected thereon and display an image;

an optical path conversion system, to split the optical paths of the fourth and fifth color lights incident from the color recycling system such that the first color light in the fourth color light is directed to the first reflective panel, the second color light in the fifth color light is directed to the second reflective panel, and the third color light in the fourth and fifth color light is directed to the third reflective panel, and direct the first through third color lights reflected from the respective first through third reflective panels to the screen; and

a projection system comprising a projection lens, which projects the fourth color light

output from the optical path conversion system and the fifth color light output from the optical path conversion system on the screen.

2. The projection apparatus of claim 1, wherein the illumination system comprises:

a light source, which emits the white light; and

a fly-eye lens integrator, which separates the white light emitted from the light source into sub beams.

3. The projection apparatus of claim 2, wherein the illumination system further comprises an ultraviolet filter on an optical path between the light source and the fly-eye lens integrator in order to block ultraviolet light in the white light.

4. The projection apparatus of claim 1, wherein the polarization conversion system comprises a prism array including a plurality of prisms having interfaces slanting against an optical axis, each of the interfaces being coated with a liquid crystal film, which reflects the first polarization component and transmits the second polarization component.

5. The projection apparatus of claim 4, wherein the polarization conversion system further comprises:

a blocking mask, disposed on the incident surface of every other one of the prisms in order to block light incident thereon ; and

a $\lambda/2$ phase plate, disposed on the output surface of each of the prisms having the blocking mask to convert the second polarization component from a P polarization component to an S polarization component .

6. The projection apparatus of claim 4, wherein interfaces of the plurality of prisms

in the prism array slant against the optical axis at an angle of 45 degrees.

7. The projection apparatus of claim 4, wherein the liquid crystal film is a cholesteric film.

8. The projection apparatus of claim 4, wherein the light of the predetermined wavelength band is the first and second color lights, and the liquid crystal film reflects the first polarization components of the first and second color lights and transmits the second polarization components thereof.

9. The projection apparatus of claim 4, wherein the light of the predetermined wavelength band is the first through third color lights, and the liquid crystal film reflects the first polarization components of the first through third color lights and transmits the second polarization components thereof.

10. The projection apparatus of claim 1, wherein the color recycling system comprises:

a color switching filter comprising a first cell and a second cell, including a first color filter and a second color filter stacked in opposite orders in the first and second cells, the first color filter to reflect the first color light in a power-on state and transmit the first color light in a power-off state, the second color filter to reflect the second color light in the power-on state and transmit the second color light in the power-off state, the first and second color filters to transmit the third color light, the color switching filter to direct the fourth color light output from the first cell and the fifth color light output from the second cell to the image forming system;

a roof mirror, to reflect light incident from the color switching filter back to the color switching filter; and

a third color filter, positioned on an optical path between the color switching filter and the roof mirror and to convert the first polarization component of the third color light reflected from the color switching filter into the second polarization component.

11. The projection apparatus of claim 10, wherein the color recycling system further comprises a prism array combiner, to refract the fourth and fifth color lights incident from the color switching filter so that the fourth and fifth color lights progress toward the image forming system along different optical paths.

12. The projection apparatus of claim 10, wherein the color recycling system further comprises a passive color filter, which reflects the first polarization component of the third color light and transmits the second polarization component thereof, on an incident surface thereof.

13. The projection apparatus of claim 11, wherein the color recycling system further comprises a passive color filter, which reflects the first polarization component of the third color light and transmits the second polarization component thereof, on an incident surface thereof.

14. The projection apparatus of claim 10, wherein the first through third color filters are cholesteric filters.

15. The projection apparatus of claim 12, wherein the passive color filter is a cholesteric filter.

16. The projection apparatus of claim 13, wherein the passive color filter is a cholesteric filter.

17. The projection apparatus of claim 10, wherein the color switching filter slants against an optical axis at an angle of 45 degrees.

18. The projection apparatus of claim 10, wherein the roof mirror comprises a first mirror parallel with the color switching filter and a second mirror orthogonal to the color switching filter and the first mirror.

19. The projection apparatus of claim 18, wherein the third color filter is disposed on an optical path between the color switching filter and the first mirror.

20. The projection apparatus of claim 1, further comprising a relay lens system, which shapes the fourth and fifth color lights, on an optical path between the color recycling system and the image forming system.

21. The projection apparatus of claim 20, further comprising a $\lambda/4$ phase plate on an optical path between the relay lens system and the optical path conversion system.

22. The projection apparatus of claim 21, further comprising a chromatic polarizer on an optical path between the $\lambda/4$ phase plate and the image forming system.

23. The projection apparatus of claim 22, wherein the chromatic polarizer is made of a liquid crystal polymer or a linearly photopolymerizable polymer.

24. The projection apparatus of claim 1, wherein the first and second reflective panels are parallel with each other, and the third reflective panel is orthogonal to the first and

second reflective panels.

25. The projection apparatus of claim 1, wherein a shadow zone, in which no pixels exist, is formed between the first and second reflective panels and at a center of the third reflective panel.

26. The projection apparatus of claim 1, wherein each of the first through third reflective panels comprises a $\lambda/4$ phase plate on an incident surface thereof.

27. The projection apparatus of claim 1, wherein the optical path conversion system comprises a polarizing beamsplitter having a transmissive/reflective surface, to reflect the first color light in the fourth color light incident from the color recycling system to the first reflective panel, reflect the second color light in the fifth color light to the second reflective panel, transmit the first and second color lights modulated by the respective first and second reflective panels to the projection system, transmit the third color light in the fourth and fifth color lights incident from the color recycling system to the third reflective panel, and reflect the third color light modulated by the third reflective panel.

28. The projection apparatus of claim 1, further comprising a wideband filter to convert the first polarization component of the third color light output from the optical path conversion system into the second polarization component, on an optical path between the optical path conversion system and the projection system.

29. The projection apparatus of claim 28, further comprising a clean-up polarizer, which removes a parasitic polarization, on an optical path between the wideband filter and the projection system.

30. The projection apparatus of claim 1, wherein the screen comprises a waveguide array comprising a plurality of waveguides slanting against an optical axis at a predetermined angle which are symmetrically arranged with respect to a center of the screen to refract the fourth and fifth color lights output from the projection system, thereby forming a unified image.

31. The projection apparatus of claim 1, wherein the first color light is blue light and the second color light is green light.

32. The projection apparatus of claim 1, wherein the third color light is red light.

33. The projection apparatus of claim 1, wherein the fourth color light is cyan light and the fifth color light is yellow light.

34. The projection apparatus of claim 1, wherein the first polarization component is an S polarization component and the second polarization component is a P polarization component.

35. The projection apparatus of claim 2, wherein the light source comprises:

a metal halogen lamp; and

a parabolic reflector to collimate the white light.

36. The projection apparatus of claim 4, wherein a width of the wavelength band is determined by the liquid crystal film.

37. The projection apparatus of claim 1, wherein a contrast of the image is 150:1.

38. The projection apparatus of claim 5, wherein the blocking masks are formed on the prisms in a striped pattern.

39. The projection apparatus of claim 1, wherein a length of the first and second reflective panels is half a length of the third panel.

40. The projection apparatus of claim 31, wherein the third color light is red light, the fourth color light is cyan light, and the fifth color light is yellow light.

41. The projection apparatus of claim 40, wherein the screen removes a region in which the yellow and magenta lights do not progress.

42. An apparatus comprising:

an illumination system to emit white light having light of a predetermined wavelength band;

a plurality of prisms, each coated with a cholesteric liquid crystal film, to convert the light of the predetermined wavelength band to a first polarization component; and

a color recycling system to separate the light of the predetermined wavelength band into a first color light and a second color light, transmit and reflect the first and second color lights, to convert a third color light to have a second polarization component, and transmit the third color light so that a fourth color light, that is a mixture of the first and third color lights, and a fifth color light, that is a mixture of the second and third color lights, progress in different optical paths.

43. The apparatus of claim 42, further comprising a screen to receive the first through third color lights modulated by the image forming system and projected thereon and

display an image without losing the white light emitted from the light source.

44. An apparatus comprising:

a screen to receive yellow and magenta lights from a plurality of reflective panels and to combine the yellow and magenta lights into a unified image, the reflective panels forming a shadow zone formed therebetween in which the yellow and magenta lights are not reflected.